Carbonaceous Aerosol Evolution

CARE Campaigns

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Motivation…

Carbonaceous aerosols = POA + BC + SOA
from urban, biogenic, & biomass burning sources

- Current model treatments carbonaceous aerosols are crude.
- Physical and chemical interactions between different sources are expected, but are poorly understood.

These factors critically limit our ability to assess the direct and indirect radiative effects of carbonaceous aerosols on climate

Key science questions…

- Most important SOA precursors from different sources?
- SOA yields dependence on different urban and biogenic SOA precursors, oxidants, pre-existing organic mass and composition, particle acidity, temperature, and RH?
- Chemical composition, optical properties, and hygroscopicity of the carbonaceous aerosols from different sources or chemical pathways?
- **Urban - biogenic interactions?**
- Biogenic - biomass burning aerosols?
- Optical properties, hygroscopicity, and CCN activity of the aerosol population as a function of degree of internal mixing?

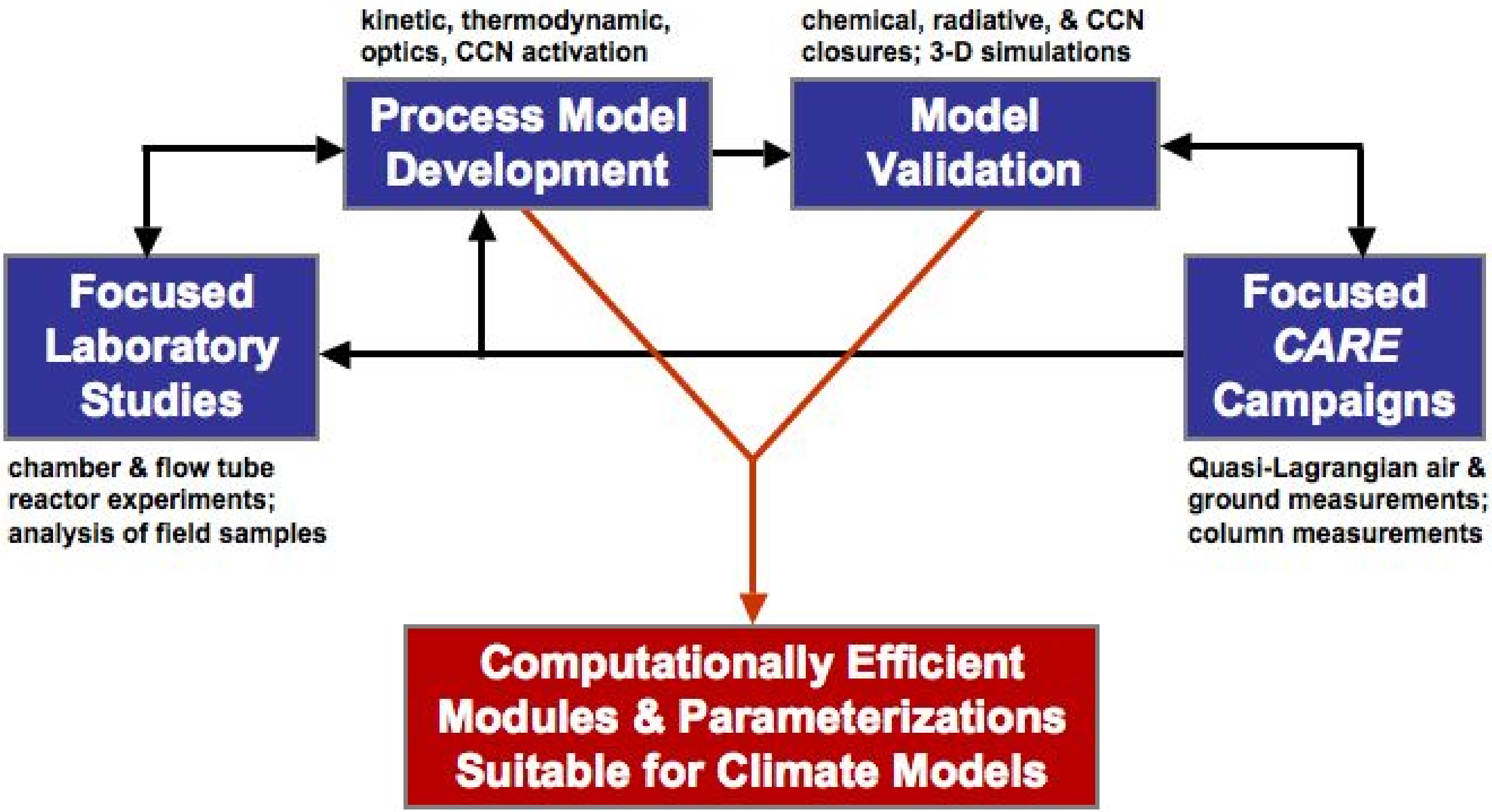
Approach…

- Single field campaign cannot solve all the problems
- Series of focused campaigns (“mini-MILAGROS”)

Series of CARE Campaigns…

CARE I: Urban Only	CARE II: Urban + Biogenic
• Isolated urban area with no biogenics; relatively uncomplicated meteorology **Outcomes:** • Understand evolution of anthropogenic carbonaceous aerosols & SOA • Optical & CCN properties of fresh and aged urban aerosols & SOA	• Isolated urban area located within a forested area with biogenic emissions **Outcomes:** • Understand interactions between biogenic and urban aerosols/precursors • Optical & CCN properties of biogenic SOA, mixed urban + biogenic SOA
CARE III: Biomass Burning + Biogenic	**CARE IV: Urban + Biogenic (diff season)**
• Rural biomass burning site with strong biogenic SOA precursor emissions in the surrounding region. **Outcomes:** • Understand evolution of BB aerosols and their interactions with biogenic SOA precursors; Optical & CCN props.	• Same site as the CARE II campaign, but in winter (colder temperatures and different urban & biogenic emissions) **Outcomes:** • Understand SOA formation from urban and biogenic precursors during winter • Compare and contrast with CARE II

Integrated lab-model-field components…



ASP products & deliverables

CARE I: Urban Only

- **Field Site:** Isolated urban area with relatively uncomplicated terrain and meteorology
  - Dallas, TX
  - Oklahoma City, OK
  - Las Vegas, NV
- **Measurement strategy:** Quasi-Lagrangian
  - Continuous sampling at multiple ground sites (e.g., T0, T1, T2)
  - G1 aircraft sampling upwind, within and downwind of the urban source region

CARE II: Urban + Biogenic

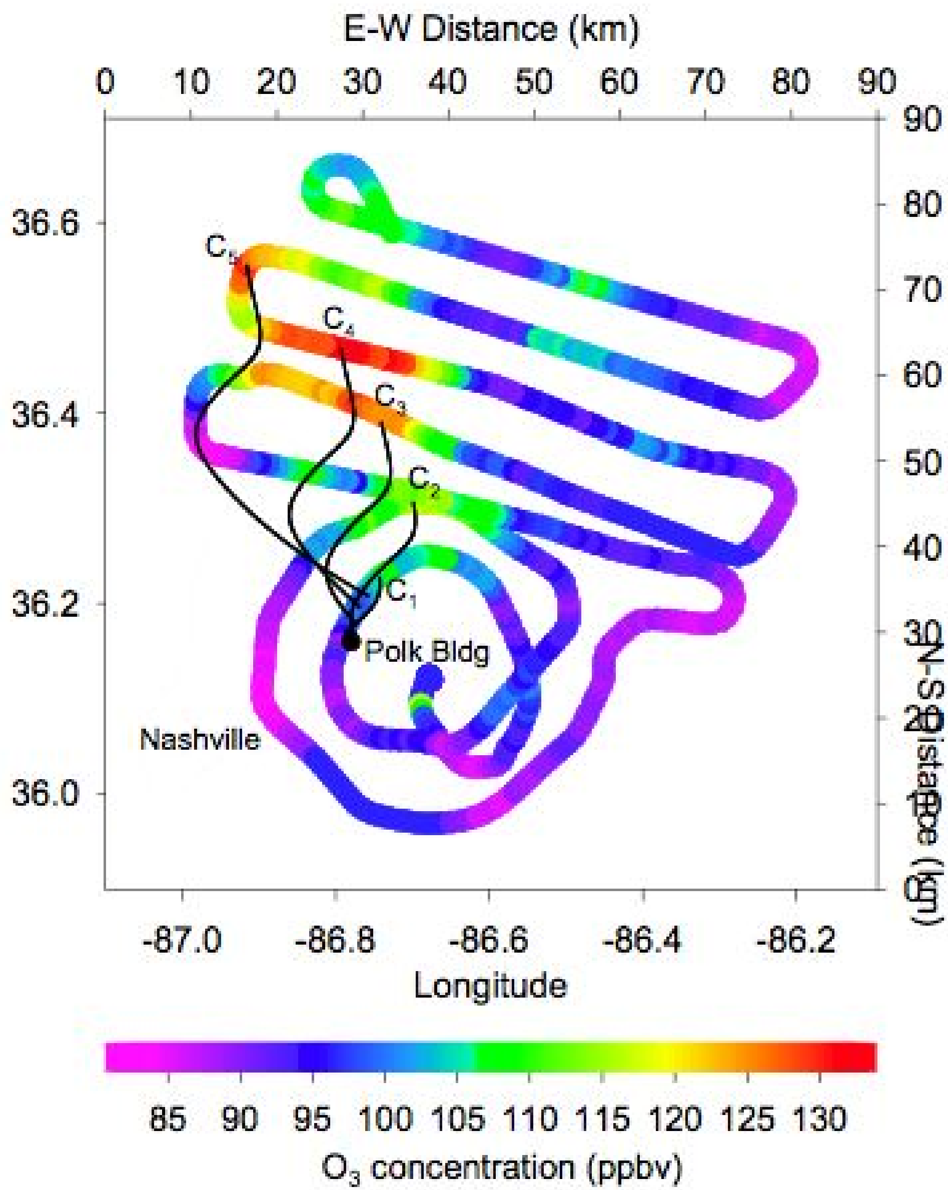
- **Field Site:** Isolated urban area with relatively uncomplicated terrain and meteorology
  - Edmonton + Saskatoon (Canada)
  - Nashville, TN
- **Measurement strategy:** Quasi-Lagrangian
  - Continuous sampling at multiple ground sites in urban and forest areas.
  - G1 aircraft sampling upwind, within and downwind of the urban source region (time-resolved)

Measurements wish list…

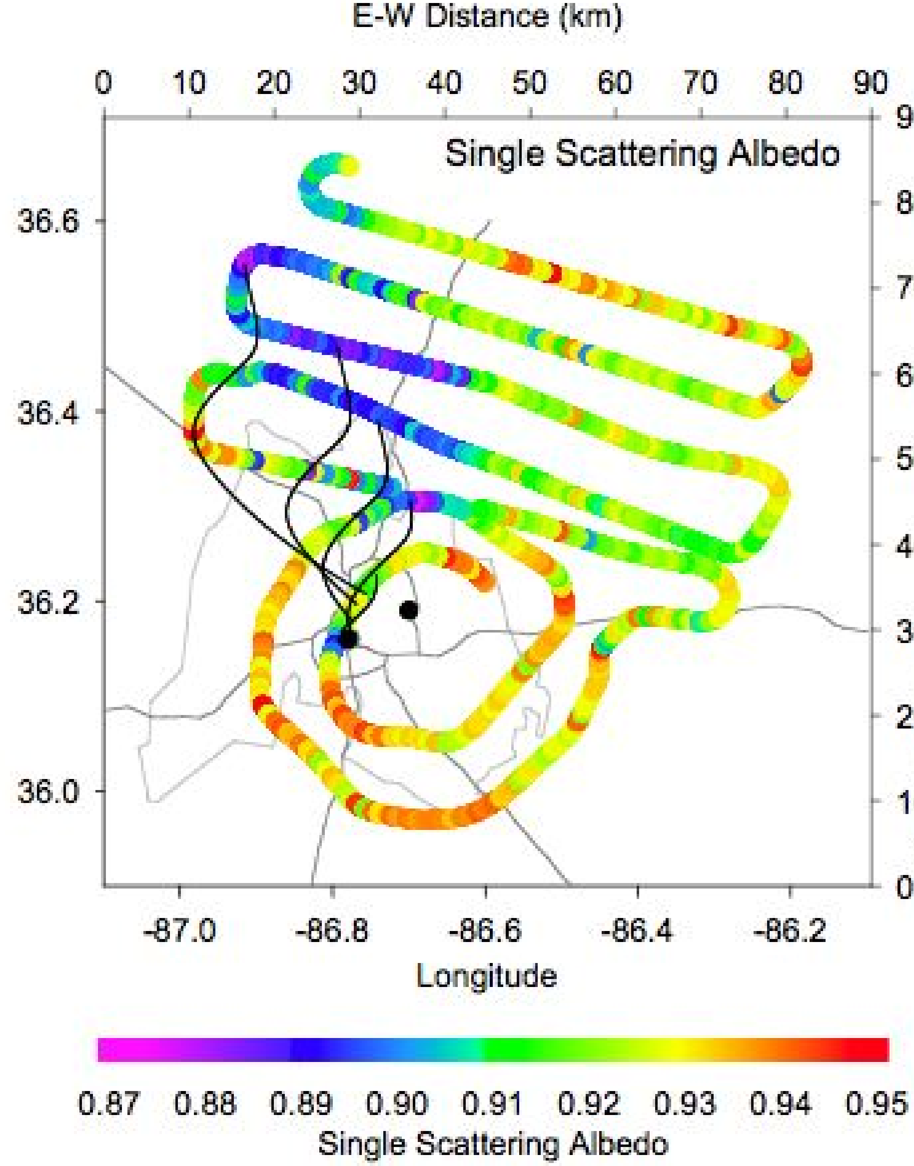
Collaboration with other agencies critical: ASP doesn't have all the measurements we need

Instrument or Measurement	G-1 Aircraft	Ground Sites
AMS, PTRMS, PILS, SP2, HTDMA	x	x
SMPS, TAG, CIMS (speciated organic aerosol matter)		x
TSEMS	x	
O_3, NO, NO_2, NO_y, SO_2, CO, NH_3, VOCs (canisters)	x	x
Radicals, peroxides		x
Nephelometer, PSAP, Photoacoustic, Cavity Ringdown	x	x
CCN counter	x	x
MAX DOAS (glyoxal, radicals over long paths)	?	x
Lab analysis of field samples: ^{14}C, morphology, etc.	x	x
Radiation measurements (e.g., MFRSR, J_{NO2}, AMF)		x
Infrastructure measurements: wind, temp, pressure, RH	x	x

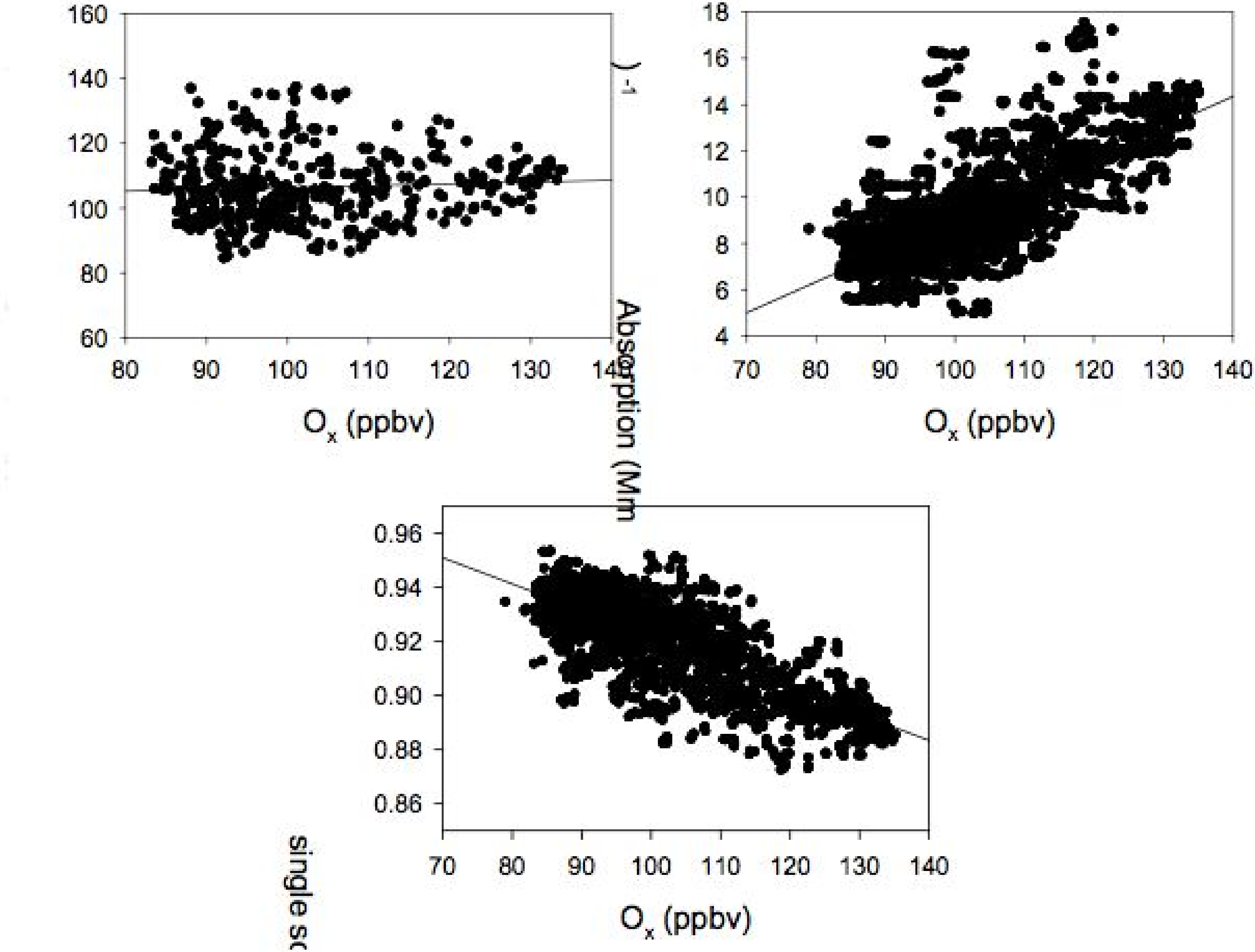
Nashville Urban Plume (SOS 1999)



Single Scattering Albedo



Aerosol Optical Properties



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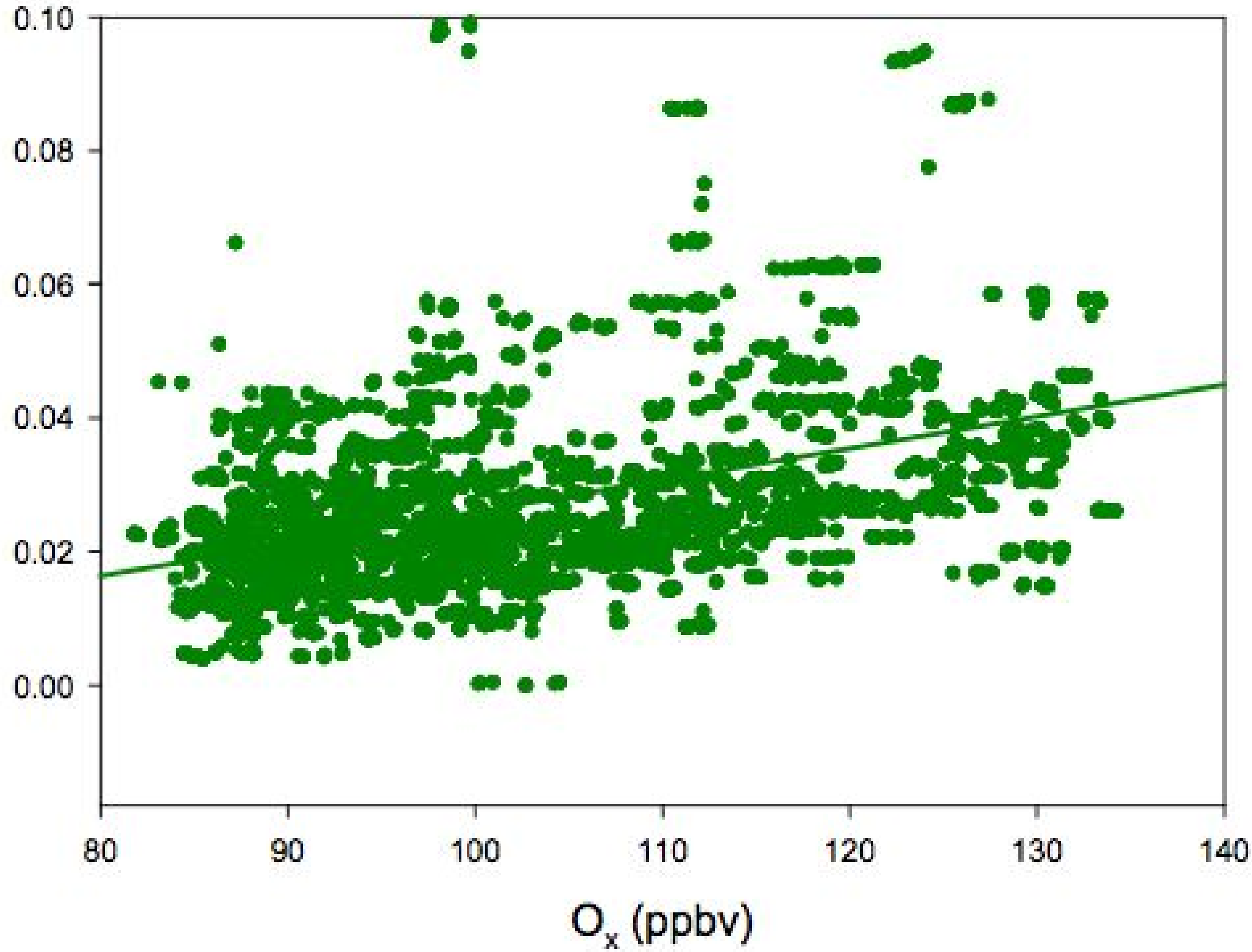

Gas Chemistry Model Evaluation
(Good understanding of ozone chemistry)

Zaveri, Berkowitz, Kleinman et al, JGR 2003